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BIOCYBERNETICS EXPERIMENT: COMMAND AND CONTROL HUMAN FACTORS EX--ETC(U)
JAN 78 T BEVAN N00014-77-C-0107
UNCLASSIFIED SAI-78-727-WA NL

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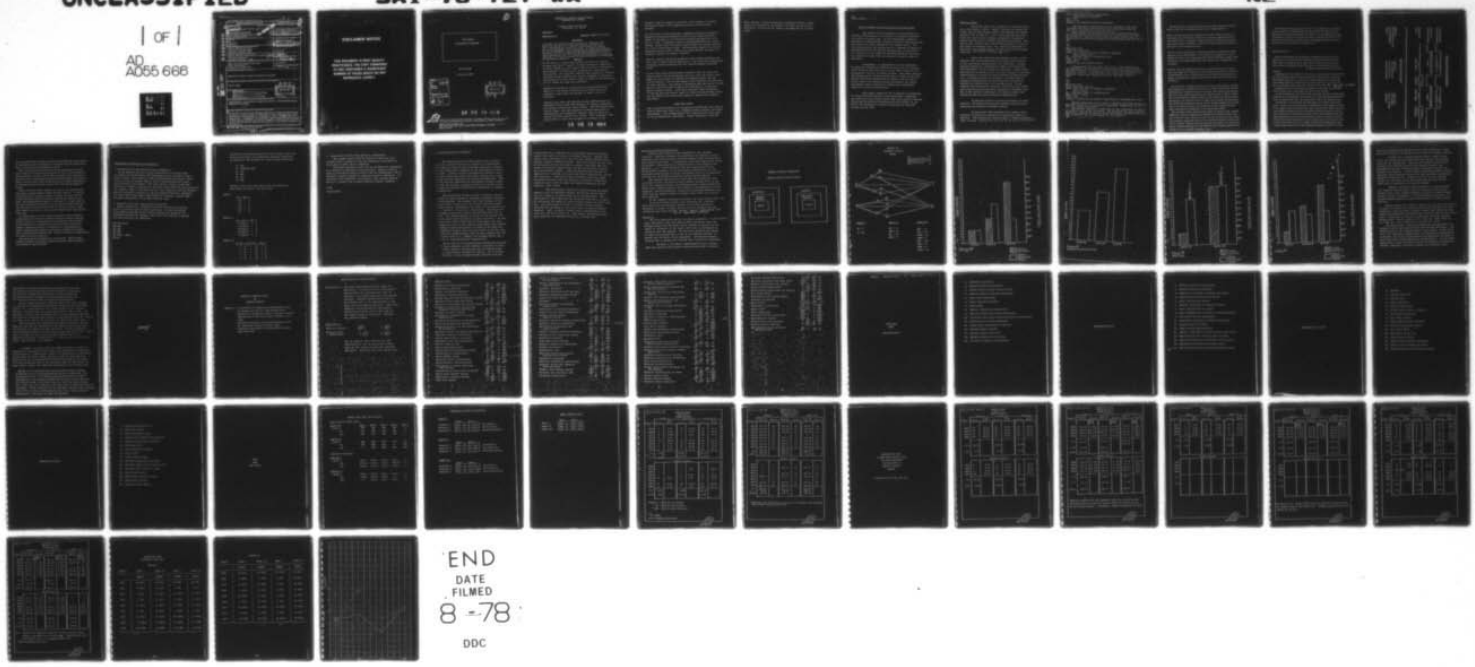

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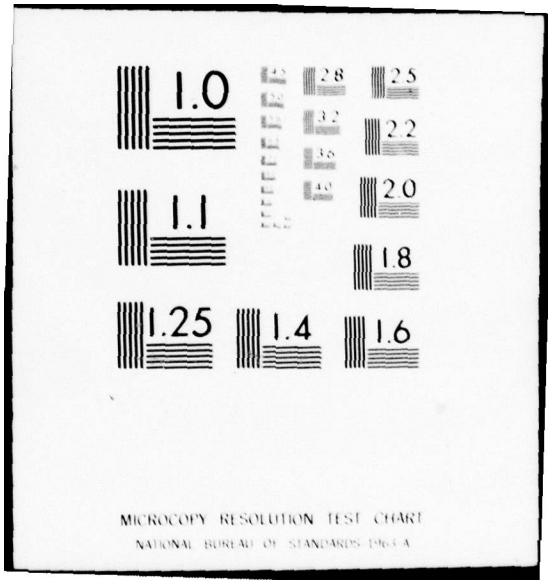
1.0
1.1
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: SAI-78-727-WA
2. GOVT ACCESSION NO.
RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): BIOCYBERNETICS EXPERIMENT: Command & Control Human Factors Experimental Program

5. TYPE OF REPORT & PERIOD COVERED: Final Report, Oct 76-Sep 77

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): T. Bevan

8. CONTRACT OR GRANT NUMBER(s): N00014-77-C-0107; MDA903-77-C-0119

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Science Applications, Inc.
1911 North Fort Myer Drive
Arlington, Virginia 22209

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NR 201-287

11. CONTROLLING OFFICE NAME AND ADDRESS
Defense Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, Virginia 22209

12. REPORT DATE: January 1978

13. NUMBER OF PAGES: 53

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
Office of Naval Research (Code 441)
800 N. Quincy Street
Arlington, Virginia 22217

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

same as above

DDC RECEIVED JUN 26 1978

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biocybernetics; human factors; command and control; electroencephalograph; information processing

C3

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

On the basis of on-site job analyses conducted at several national military C³ centers, message sorting was identified as both a highly critical center function and as a man-machine task amenable to future onling biocybernetic applications. Consequently, the experiment reported here simulated a computer-assisted message handling task and was designed to manipulate the difficulty of that task in order to identify EEG correlates of low, medium and high task difficulty.

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FINAL REPORT

BIOCYBERNETICS EXPERIMENT

SAI-78-727-WA

(19 January 1978)

ATLANTA • ANN ARBOR • BOSTON • CHICAGO • CLEVELAND • DENVER • HUNTSVILLE • LA JOLLA
LITTLE ROCK • LOS ANGELES • SAN FRANCISCO • SANTA BARBARA • TUSCON • WASHINGTON

SCIENCE APPLICATIONS, INC.
1911 North Fort Myer Drive, Suite 1200, Arlington, VA 22209
(703) 527-7571

COMMAND AND CONTROL HUMAN FACTORS EXPERIMENTAL PROGRAM

Science Applications, Inc.
Arlington, Va. 22209

ASSISTED BY

WORK UNIT NO. NR

CONTRACT MDA903-77-C-0119

OBJECTIVES

To assess the utility of EEG measures as indicators of cognitive workload in a military message sorting task: (a) to determine how evoked potentials relate to experimentally manipulated task difficulty, to speed and accuracy of task performance, and to subjectively experienced cognitive workload; and (b) to determine the discriminability of waveforms associated with low, medium and highstates of cognitive workload, for future purposes of online modulation of workload in man-machine systems.

ABSTRACT

On the basis of on-site job analyses conducted at several national military C^3 centers, message sorting was identified as both a highly critical center function and as a man-machine task amenable to future online biocybernetic applications. Consequently, the experiment reported here simulated a computer-assisted message handling task and was designed to manipulate the difficulty of that task in order to identify EEG correlates of low, medium and high task difficulty.

Cognitive workload was conceptualized and manipulated as a function of the number of decisions the human sorter was required to make about the message in order to sort it correctly.

Several pilot tests and resulting design modifications were completed before online EEG recording of subjects performing the message sorting task could proceed. When EEG measurements did not begin, they were measures of evoked potentials to statistically low probability auditory tones to which the subject had been instructed to attend. This "secondary" task of attending to tones was designed as a measure of the

residual cognitive capacity available to the subject at various difficulty levels of the competing primary task of sorting messages.

At each level of task difficulty, dependent measures included the behavioral sorting performance as well as the evoked potential number of messages to be sorted were briefly displayed on a CRT, one at a time. A response internal outlined/followed the message display, during which the subject could record his sorting decision on a six by seven manual blank. EEG recording sampled the message displayed interval and no tones were played through the subject's earphones during the response interval.

Several designs and design parameters were tested throughout the year, due to unanticipated difficulty in the successful manipulation of message sorting accuracy for low, high and medium difficulty levels.

In the final design which proved acceptable only the lowest and highest levels of task difficulty were run, with the lowest level requiring the subject to consider one message feature for its correct sorting, and with the highest level requiring consideration of those features. The features determined both the correct sorting division and the correct response for recording it on the six-button response device. Pilot data indicated large differences in sorting accuracy between these two levels and online EEG recording was added to this behavioral design to provide the complete experiment.

PLANS FOR FUTURE

Data analysis procedures for interpreting the EEG data and relating them to behavioral data (i.e., message sorting accuracy) are under development. That accomplishment will constitute the final phase of the biocybernetics experiment. Visual inspection of the EEG

data, however, reveals discernable differences between evoked potentials recorded at the highest and lowest levels of task difficulty, in terms of the latency and magnitude of the waveforms.

BC
FINAL REPORT:

Overall Purpose and Original Design of Experiment

The purpose of the experiment was to examine the utility of EEG measures as correlates of cognitive workload in a message sorting task. In this experiment, cognitive workload was operationally defined in terms of the information-processing load (IPL) imposed on the message sorter. IPL was conceptualized and manipulated as a function of objective characteristics of the message sorting task, in particular as a function of the number of discreet decisions the sorter was required to make about the message in order to sort it correctly.

Accordingly, an experimental task was designed in which the subject was required to sort a set of messages, under different sets of decision rules which ranged in IPL requirements from low to medium to high. Once these objective IPL manipulations had been checked both in terms of the subjective difficulty experienced by subjects and in terms of actual effects on message sorting performance, the search for possible EEG correlates of subjectively experienced cognitive workload could proceed.

This report summerizes SAI's progress in performing the biocybernetics message sorting experiment, recounting our experience with several pilot tests and resulting research design modifications, and culminating in the results of our online EEG recording as subjects performed the finalized message sorting task.

Original Design

The S was required to roleplay as a message sorter in a civil defense office. His/her task was to examine the "from" line in each message header (see Appendix for sample messages) and to make one, two or three discreet decisions about the source of the message, according to predefined message sorting rules in which S had been pre-trained. IPL levels (low, medium, high) were thereby defined in terms of the number of decisions (one, two, three) S would have to make about the message source, in order to sort the message correctly. (SEE SAMPLE MESSAGES, Figure 1.)

Given this objective manipulation of IPL, it was expected that sorting omissions and errors would increase as the task became progressively more difficult. Initial research focused on a manipulation check of the objective IPL requirements of the message sorting task. Specifically, did objective manipulations of IPL yield evidence of increased task difficulty in terms of actual message sorting behavior (i.e., sorting omissions and errors)? A second check on successful manipulation of task difficulty involved the analysis of reaction time to a secondary task. It was expected that progressive increases in objective task difficulty would lead to progressive increases in secondary task RT, if the subjective experience of message sorting task difficulty had also been successfully manipulated.

If pretests failed to confirm successful IPL manipulation, the message sorting task would be revised until a successful manipulation had been achieved.

At that point, EEG recording would replace RT as potential indicator of subjectively experienced cognitive workload. EEG measurements would be made of evoked potentials (EPs) to "rare" auditory tones to which S was instructed to attend.

REFS: BULLETIN 1362
FROM: CALIFORNIA ENERGY COMMISSION/
COMMISSIONER RATCHFORD
TO : UPI
DATE: 1449
SUBJECT: REFRIGERATOR ENERGY STANDARDS

THE CALIFORNIA ENERGY COMMISSION ANNOUNCED TODAY THAT TWO MAJOR NATIONAL MANUFACTURERS HAVE VOLUNTARILY ADOPTED THE CEC'S REFRIGERATOR ENERGY STANDARDS.

BOTH PHILCO AND WESTINGHOUSE PLAN TO BEGIN PRODUCTION OF THE NEW MODELS WHICH COMPLY WITH THE COMMISSIONS STANDARDS NEXT JANUARY. INITIAL DISTRIBUTION OF THESE MODELS WILL BE PILOT TESTED IN SELECTED MARKETS IN PENNSYLVANIA AND NEW YORK.$$
001

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M
BULLETIN #002
REFS: BULLETIN #374
FROM: U.S. MARINE FISHERIES SERVICE, WASH DC/
INFO DIRECTORATE
TO : US ARMY CORPS OF ENGINEERS, UPI
DATE: NOV 11, 1976
TIME: 1053
SUBJECT: BAN ON PORPOISE KILLS

A BAN ON KILLING OF PORPOISES BY U.S. TUNA FISHERMAN OR AS A BYPRODUCT OF ENVIRONMENTAL ALTERATIONS FOR FLOOD CONTROL OR OTHER PURPOSES WAS ANNOUNCED YESTERDAY BY THE NATIONAL MARINE FISHERIES SERVICE. THE BAN WILL LAST UNTIL THE YEAR'S END. A QUOTA OF 78,000 DEAD PORPOISES WAS SET FOR THIS YEAR.$$
100

***
M
BULLETIN #003
REFS: BULLETIN #380,347
FROM: MARYLAND DEPT OF NATURAL RESOURCES/
SEC'Y MILLER
TO : US ARMY CORPS OF ENGINEERS,UPI
DATE: SEPT 14:1976
TIME: 1304
SUBJECT: OPPOSITION TO FEDERAL REGULATION OF YOUGHIOGHENY RIVER

STRONG OPPOSITION TO THE CORPS' PROPOSED LAND PRESERVATION RE HAS BEEN EXPRESSED BY AN AD HOC LANDOWNERS' ASSOCIATION TO THE MA DEPT OF NATURAL RESOURCES.

THE PRIMARY SOURCE OF OPPOSITION IS THE LIMITATION ON DEVELOP OF PRIVATE LAND ALONG THE RIVER. THE HOSTILITY OF THE LANDOWNERS' GROUP HAS EXTENDED TO RUNNING STATE AND FEDERAL OFFICIALS OFF THEI AND TO DENYING THE PUBLIC ACCESS TO THE RIVER.$$
101

Figure 1

The decision rules originally used to develop three progressively difficult levels for the message sorting task are explained below:

Level I message sorting rules required S to decide whether the source of the message was from within a defined six state area (intra-regional) or from without (extra -regional). During the Level I session of the experiment (approximately 20 minutes) , S made the intra-regional/extra-regional decision for each message presented.

Level II message sorting rules required S to make a second decision about the message source. In addition to the regional decision, S has to decide whether the source was a government body (whether municipal, county, state or federal) or a nongovernment body. This session also ran approximately 20 minutes.

Finally, Level III message sorting rules, designed to impose the largest IPL on S, required that S make the two preceding decisions and a third decision--whether or not an individual's name was listed for the source or simply an organization, agency or other group. This Level III session ran 20 minutes.

For each level, dependent measures were taken in the same way. Messages were displayed on a CRT and came up one at a time for the subject's review. Each message was displayed exactly 15 seconds, after which it was removed from the screen. Another message did not replace it for 5 seconds. During the 15-second message display interval, S had to make and retain his/her decision(s), but could not record it until the 15 seconds had elapsed and the message had disappeared from the screen. His/her opportunity to record one, two or three decisions came during the 5-second response interval which separated the presentation of one message from another.

For recording his/her decisions the subject was supplied with a special keyboard on which six separate keys represented the binary choices (one, two or three of them) (s)he had to make for each decision task. S was told that responses registered outside of the specified 5-second interval would not be recorded. Responses were made with the right hand. (In a pre-experimental training session S was fully familiarized with these procedures and brought up to a criterion performance level.)

As a secondary task, S was presented with rare auditory tones randomly presented during the 15-second message display interval. Rare and frequent tones were presented during the interval and the subject was asked to respond to only the rare tones by pressing a button held with his left hand. Each button press recorded time in milliseconds between rare tone presentation and the subject's response to it.

INSERT DIAGRAM # 2

Ss were individually run in 85 minute experimental sessions, during which the IPL was varied to four different levels (a baseline IPL level where only the secondary task is run, level I, level II and level III) with a brief rest between levels. The order of the IPL levels presented was counter balanced within and between subjects.

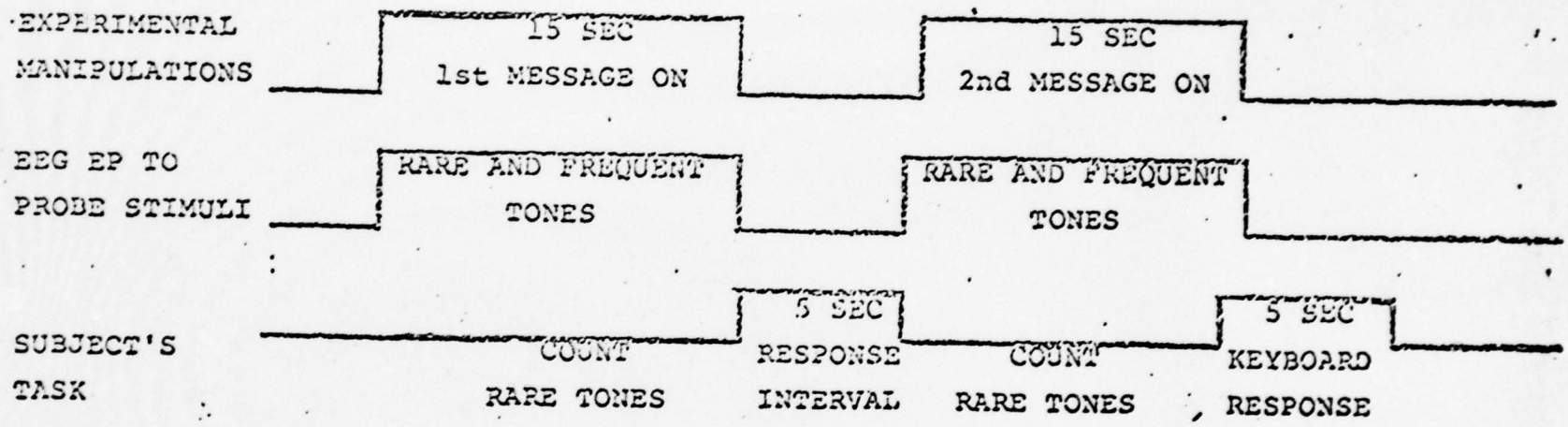
Resulting data showed that IPL had not been successfully manipulated with the three message sorting levels. S performance did not show a graduated deterioration from Level I to Level III. Performance data on the primary task showed slight but insignificant increases from Level I to Level III, but an inordinately high error rate on the Level II task. (See "DATA FROM 1ST DESIGN" APPENDIX)

Reaction time to the secondary task showed a very slight increase from level to level, with a wide range per level across subjects.

It was concluded that the three levels of message sorting task difficulty would have to be redesigned, so that the levels were more discriminable in terms of primary task error rate and reaction time on the secondary task.

Furthermore, the large error rate associated with primary task performance at Level II was interpreted as a consequence of the ambiguous nature of the decision task required at that level. Specifically, whereas the intra/extra regional decision and the person/office decision could be correctly made on the basis of information provided within the experimental task; the government/private decision required pre-experimental knowledge of governmental and private organizations used as message sources. The nature of the decision to be made at Level II thereby required more interpretation and perhaps guessing that did the more objective decisions of Levels I and III.

MESSAGE SORTING EXPERIMENT



MANIPULATION OF IPL:

LEVEL I:
INTRA-REGIONAL OR EXTRA-REGIONAL SOURCE

LEVEL II:
ADD GOVERNMENT, NON-GOVERNMENT SOURCE DECISION

LEVEL III:
ADD PERSON AGENCY SOURCE DECISION

Diagram II

It was concluded that the Level II decision would either have to be replaced or controlled for level of ambiguity, on the basis of general public awareness of organizations as governmental or public.

First, an attempt was made to replace the government/private decision with a substitute decision task more similar in nature to the objective decisions required at Levels I and III. The new decision task required S to determine whether each message's three-digit reference number fell above or below a criterion number. This new decision task was simply substituted for the government/private decision, and the rest of the design remained unchanged.

Results did indeed show a reduced error rate for the second decision task. However, another problem emerged. All three levels (I , II and III) of difficult showed virtually no errors, even when the time frames for message presentation and for the response interval were drastically reduced. (The message-display interval was shortened to 7 seconds, with the last three reserved for recording responses.) Shortening these intervals even more would seriously interfere with our ability to present a sufficient number of rare tones to evoke and sampe adequately the EEG component under study.

In a third design, all three levels were changed, using a Sternberg-type paradigm. Subjects were to determine whether the message source did or did not belong to an identified set of organizations. The difficulty of their decision was increased from level to level by increasing the number of organizations within the identified set. Time parameters involved a 4-second message display, fo l lowed by a blanking of the screen and a 3-second response interval. Thus, at Level I there were 4 organizations, 8 at Level II and 16 at Level III.

This design was also abandoned when resulting data failed to show a graduated increase in performance errors and reaction time was shown not to be related to task difficulty.

Recommendations Which Led to Design IV

1. Manipulation of IPL Using Cumulative Responses.

It was hypothesized that better manipulation of workload might be achieved by establishing interdependence between responses. Under such a design, three decision tasks (inside/outside the region, above/below a criterion message number, form an individual/office) would still be made by the subject, but (s)he would no longer record them separately. Instead, decisions at all three levels would be registered with one response. Thus at the second level, four responses would be possible, given two possible responses to the two required decisions. Similarly, the third level would imply eight different responses, related to all possible combinations of the three decision tasks.

2. Manipulation of IPL Using Logical Operations.

Another possibility considered involved requiring the message sorter to perform logical and/or operations, as (s)he determines from his/her knowledge of the primary addresee who should be the secondary addressee(s). Messages would have to be edited to include the following primary addressees:

(A) Red Cross
(B) UPI
(C) CDC
(D) HEW
(E) White House
(F) AP

Decisions rules would be given to the message sorter with which to determine the appropriate secondary addressee by looking at the message "to" line (primary addressee).

1) NIH
2) INTERIOR DEPT.
3) DoD
4) HUD
5) FEA
6) EPA

Decision rules vary with each level and increase in difficulty from Level I to Level III:

LEVEL I

If A, Then 1
" B, " 2
" C, " 3
" D, " 4
" E, " 5
" F, " 6

LEVEL II

If A and B, then 6
" B and C, " 5
" C and D, " 4
" D and E, " 3
" E and F, " 2
" F and A, " 1

LEVEL III

If not A and not B, then 1
" B " C, " 2
" C " D, " 3
" D " E, " 4
" E " F, " 5
" F " A, " 6

3. Manipulation of IPL using Ambiguous Information.

The message sorter would be required to make only one decision (gov't, nongov't), but the information with which he is to make it would vary in ambiguity.

Decisional ambiguity would rely on the degree of commonality of a variety of government agency acronyms. Subjects would be biven a time-limited multiple-choice task of deciphering a set of government agency acronyms to establish levels of ambiguity. To facilitate data collection and analysis, this testing would be done at a terminal with a simple keyboard response required.

4 MDS

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Unsuccessful Designs I, II and III

The identification of EEG correlates of cognitive load in a message sorting task requires an experimental design in which pretesting has confirmed successful manipulation of IPL requirements composed by the experimental message-sorting task. Several attempts to manipulate cognitive workload in this manner have been undertaken, and the most recent design most closely approaches the desired manipulation. This report will briefly summarize the experimental designs tested to date and will present in greater detail the current design and a slight modification which will be undertaken to increase its acceptability.

The unsuccessful designs varied in several ways but were similar in their purpose of imposing incremental decision loads on the subject. For example, the first design required the message sorter to make one, two or three decisions about each message sources, depending on the level of the experimental condition -- Levels I, II and III, respectively. Responses were recorded separately by the subject for each decision task at each level. The message-display interval was 20 seconds, the last five of which were allowed for response recording. As with subsequent designs which will be described in this report, the goal was to design the task so that subject performance would decline in a graduated fashion from Level I to Level II to Level III. Pretests indicated minimal error rates at Levels I and III, with a high error rate (approximately 30%) for many subjects for the second decision task (i.e., whether the messages source was a "governmental" or "nongovernmental" organization).

It was felt that the government/nongovernment decision may have been ambiguous to some subjects, depending on their experimental level of familiarity with the organizations named in the experimental messages as sources. In the second design, therefore, a more straight-forward decision task was

substituted (i.e., whether the three-digit message reference number fell above or below a criterion number). Results did indeed show a reduced error rate for the second decision task. However, another problem emerged. All three levels (I, II, III) of difficulty showed virtually no errors, even when the time frames for message presentation and for the response interval were drastically reduced. [The message-display interval was shortened to 7 seconds, with the last three reserved for recording responses.] Shortening these intervals even more would seriously interfere with our ability to present a sufficient number of rare tones to evoke and sample adequately the EEG component under study.

The third design involved a Sternberg-type paradigm. Subjects were to determine whether the message source did or did not belong to an identified set of organizations. The difficulty of their decision was increased from level to level by increasing the number of organizations within the identified set. Time parameters involved a 4-second message display, followed by a blanking of the screen and a 3-second response interval. Thus, at Level I there were 4 organizations, 8 at Level II, and 16 at Level III. Once again, a graduated error rate could not be obtained from Level I through III.

Pretesting Message source names

Previous data indicated some ambiguity in the stimulus materials. Objective measures of performance and subjects' verbal reactions after the experiment revealed unequal level of faviliarity with organization names. To control for this pre-experimental source of variance a questionaire was administered to nine subjects (see Appendix ____0. Little ambiguity had been associated with the person/office decision, so the questionaire dealt only with the government/nongovernment decision (previously found to be ambiguous) and with the new health-related/not health related decision.

The ambiguity questionaire identified 192 unambiguous names as message sources for each of three separate message files in the level two response category (gov't/nongovernment; health/nonhealth). Within each response category (gov't/health, private/health, gov't/nonhealth, private/nonhealth), elimination proceeded backwards from items with the highest number of subject errors until two criteria were acheived:

1) the category contained 16 sources, for each message file, and

2) no source had a higher error rate than 2/9 (subjects).

Both goals were successfully reached for all four categories. Occurance of person or office for the level II sorting task was randomized with each file. (SEE ASSIGNED SOURCES QUESTIONNAIRE AND LIST OF ACCEPTABLE SOURCES)

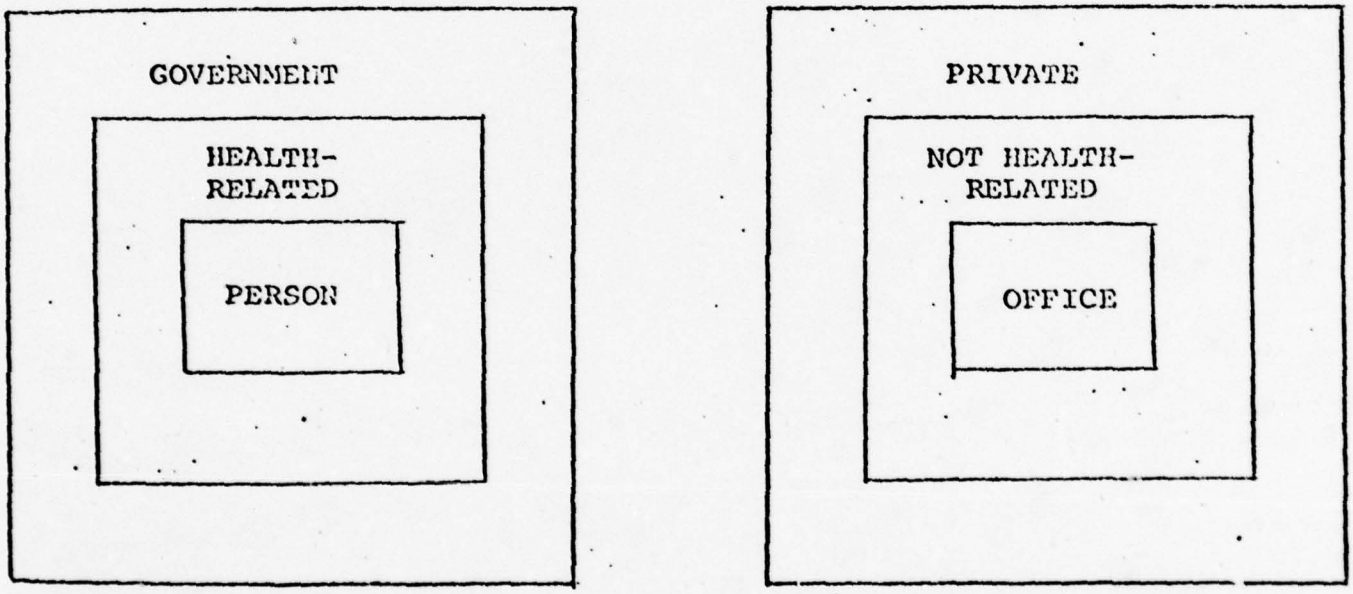
Design IV

The final behavioral design has proven acceptable. In this experiment, the subject must also make category decisions about the message source, but the three levels involve an increase in the number of "features" of the source which must be considered to correctly sort the message. The task also requires the subject to "map" his response back to one of two response buttons, no matter what the level of the experiment. The message-display interval was 4 seconds and 2 seconds were allowed for responding.

At Level I, he makes a "government/private" decision about the nature of the sources (Organizations used as sources

MESSAGE SORTING EXPERIMENT

TRIPLE NESTED DECISION TASKS

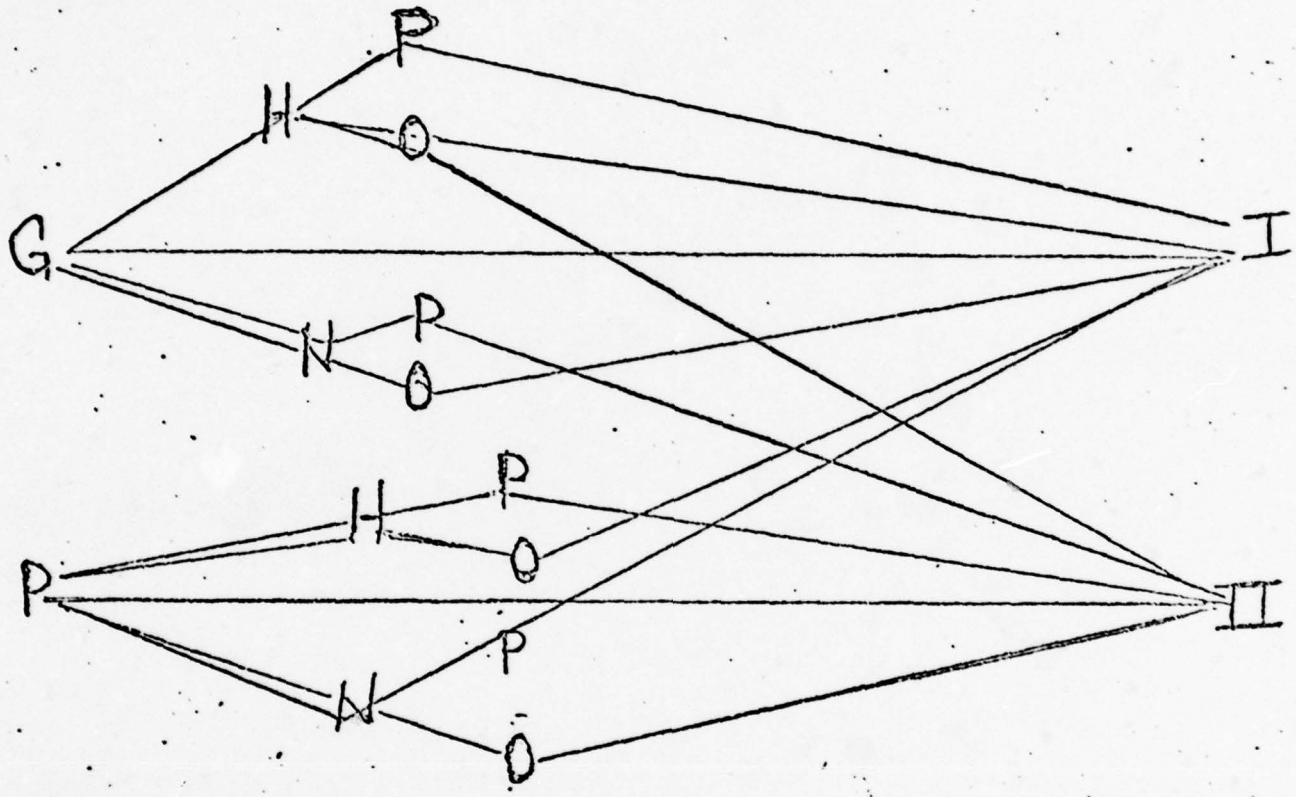


DESIGN IV

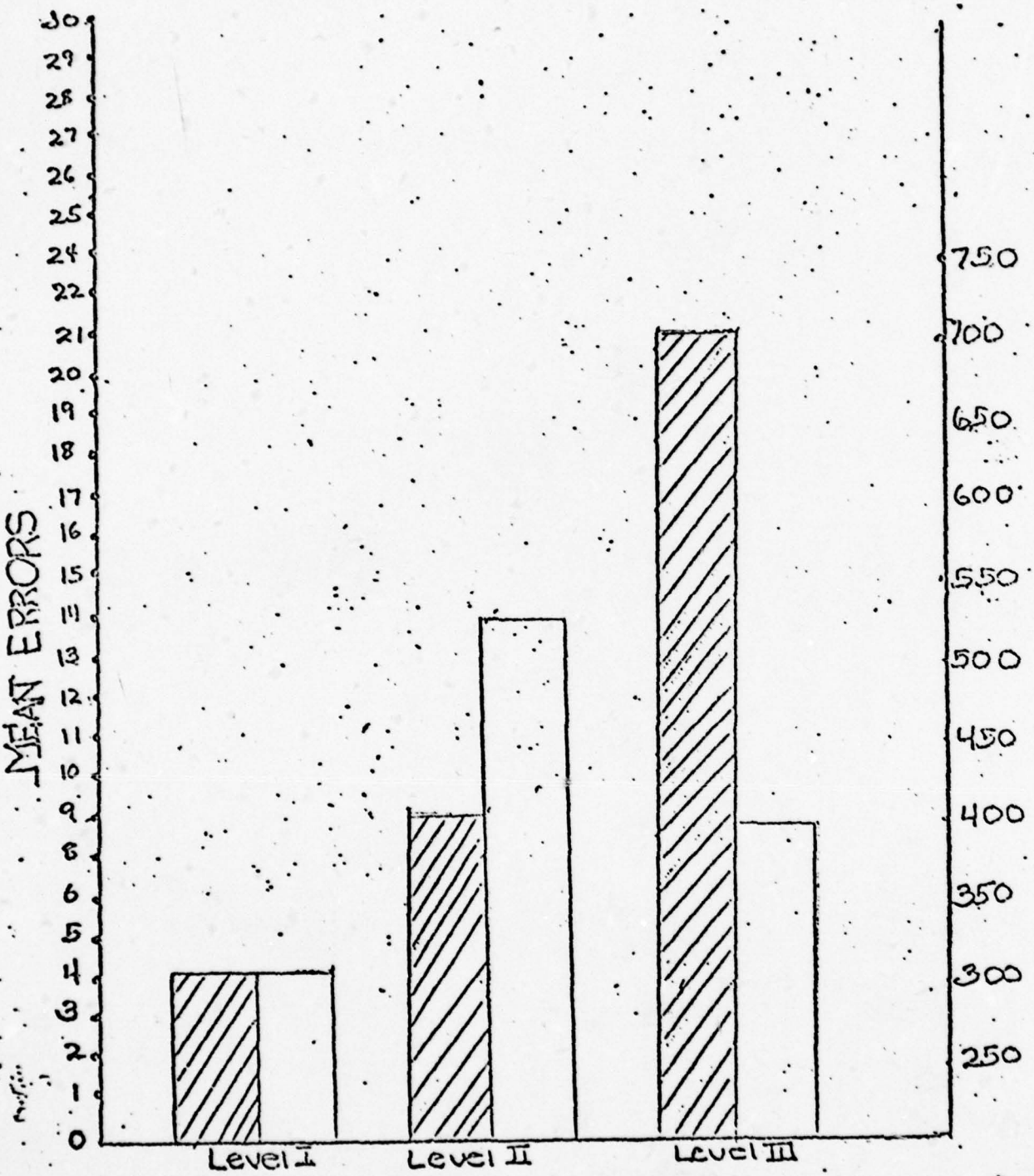
RESPONSE MAPPING

RULES

[Government/Private
Health/Not Health
Person/Office]



Level I	Level II	Level III
G = I	GH = I	GHP = I
P = II	GNH = II	GHO = II
	PH = II	GNHP = II
	PNH = I	GNHO = I
		PHP = II
		PHO = I
		PNHP = I
		PNHO = II


MEAN ERRORS
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9
8
6
5
4
3
2
1
0
MEAN REACTION TIME
750
700
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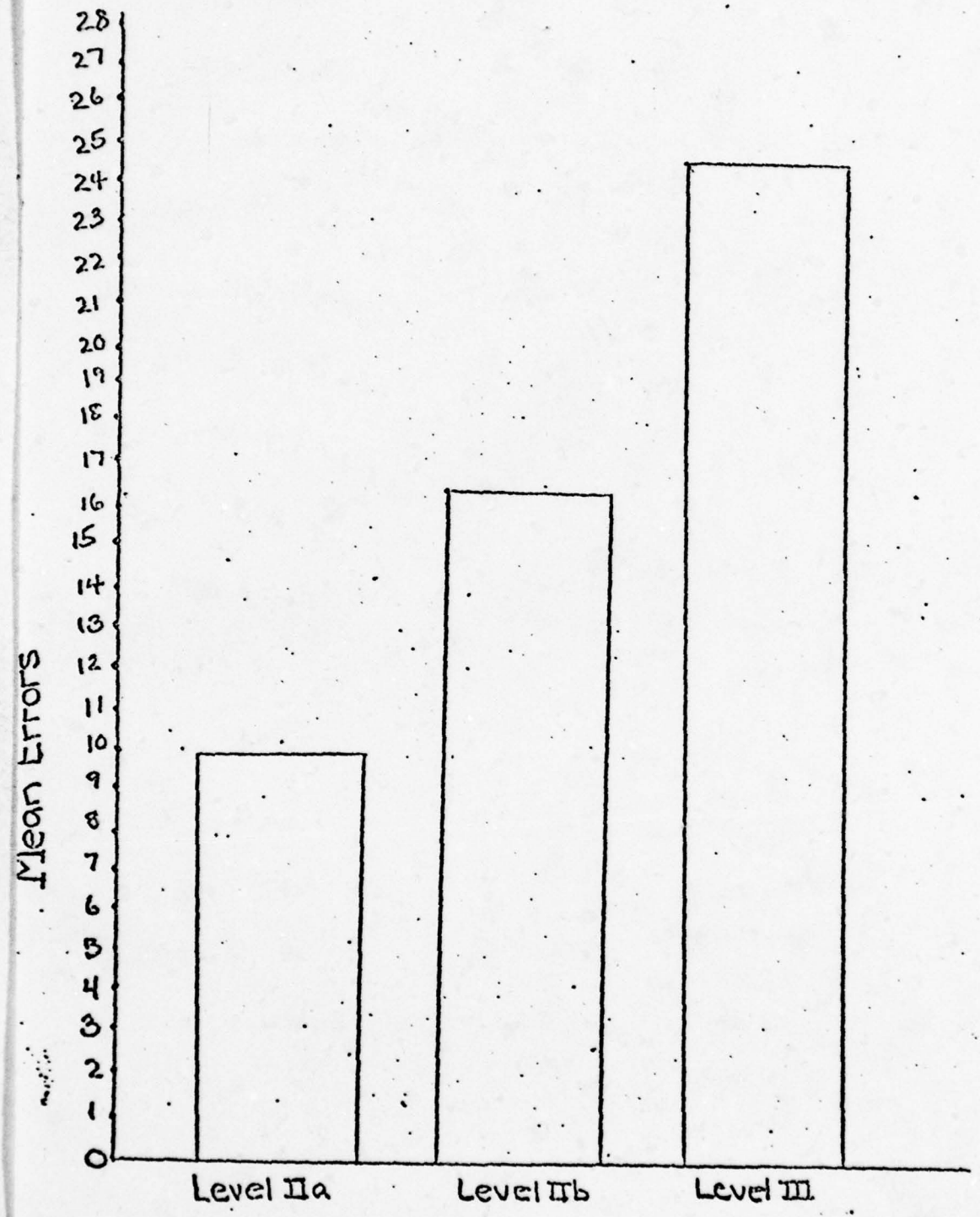
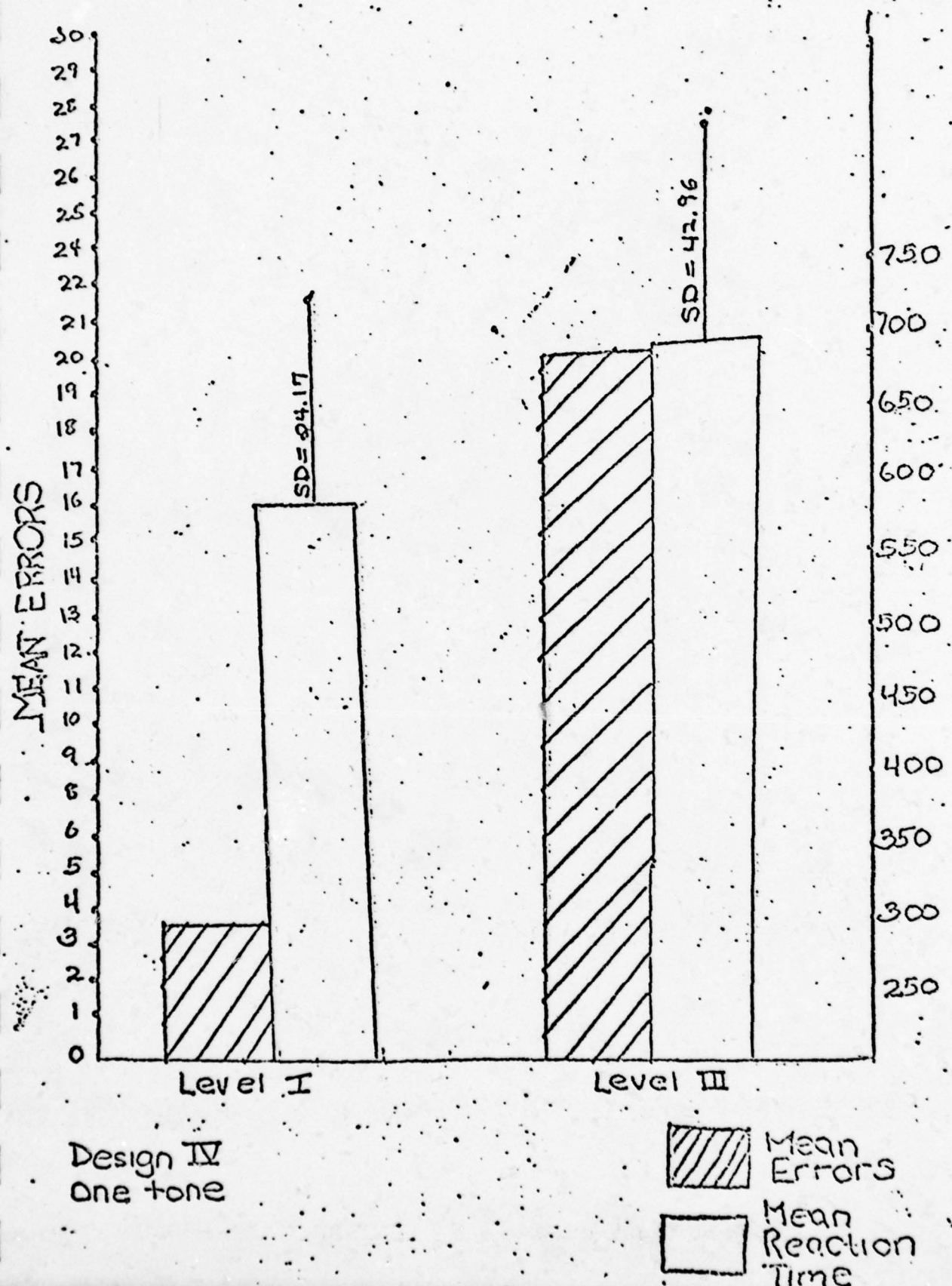
250
Level I
Level II
Level III
Mean Errors
Mean Reaction Time

Design IV



Design IV
Level II modification test


MEAN ERRORS
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5
4
3
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1
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SD = 24.17
SD = 42.96
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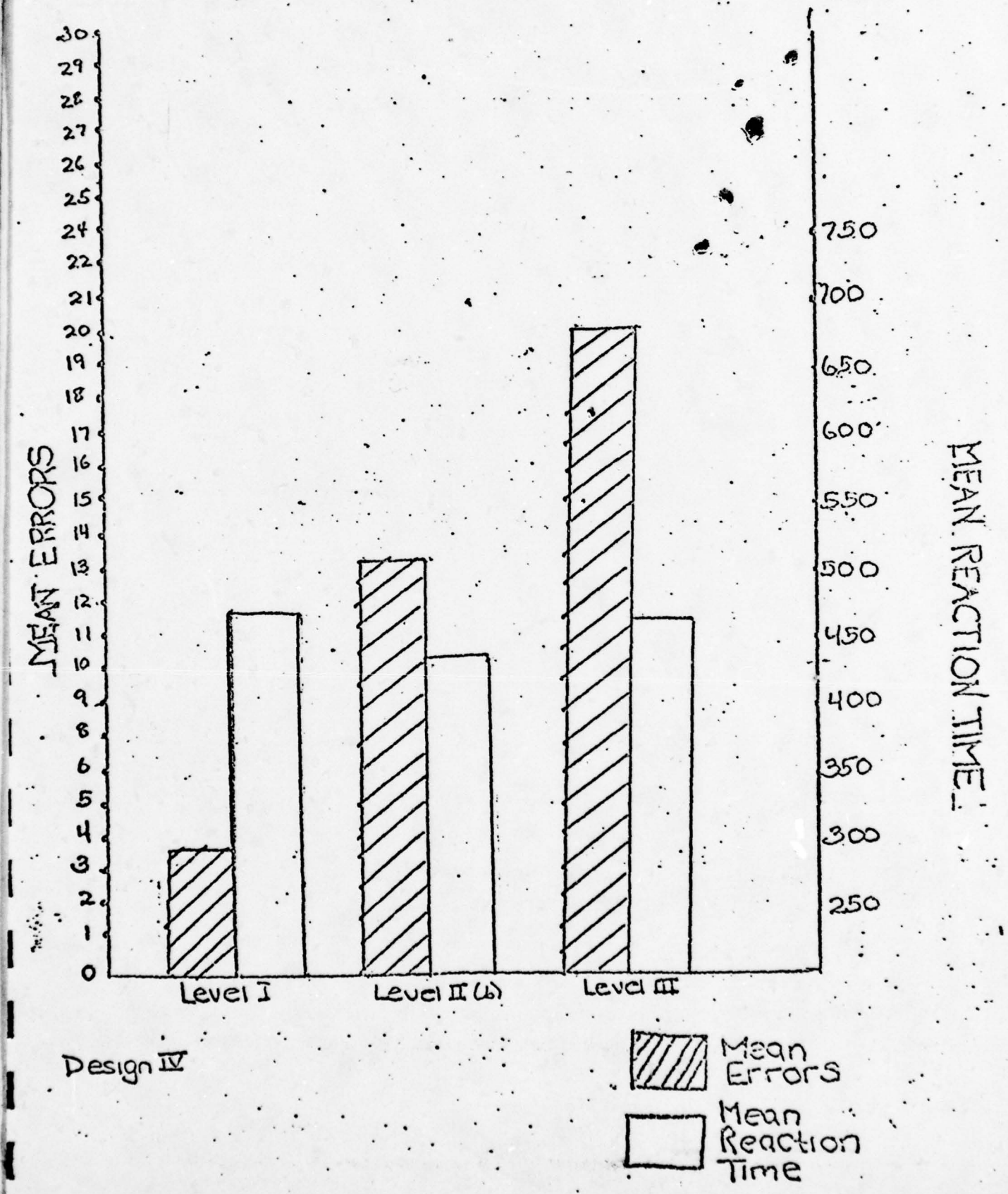
MEAN REACTION TIME
Level I
Level III
Design IV
One tone
Mean Errors
Mean Reaction Time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MEAN REACTION TIME
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Level I
Level II (b)
Level III
Mean Errors
Mean Reaction Time

Design IV

have been pretested and ambiguous items were eliminated.) Each decision alternative is mapped to one of the two response buttons.

At Level II, a second decision task is added to the first, but unlike the previously described design, the decision tasks are not independent. That is, the results of the second decision task ("health-related"/"not health-related") are accumulated with the government/private decision to yield four decision alternatives. (These "health-related/non health-related" decisions about messages sources were also pretested to eliminate ambiguous organizations.) Mapping rules to the two response buttons are such that in all four cases both features of the source must be considered for correct mapping.

Finally, the third level accumulates a third decision task (whether an individual's name is presented on the second message source line, office/department, division or other organizational group is presented -- a "person/office" decision), and response mapping requires correct understanding of three source features.

Results indicated a gradual increase in error rate from Level I to Level II to Level III (reaction time in the secondary rare tone recognition task described in design I proved less related to the objective manipulation of workload than did error rate in the primary task). Graduation in error rate accelerates much more quickly betewwn Level I and II; (Level I; $\bar{x} = 4.00$; sd - 2.00, Level II: $\bar{X} = 9.00$; sd = 10.72; Level III: $\bar{x} = 21.20$; sd = 5.63).

For this reason, a Level II modification was explored in an attempt to find a more intermediate level of task difficulty. Two modifications of the original Level II were tested. In the first, (IIA), all government organizations are immediately categorized on on feature, but private organizations are categorized in terms of three dimensions (health/nonhealth; person/office). In the second modification, (IIB) government sources are sorted on two features (health, nonhealth) and private sources are sorted on three.

After practice, Ss showed a mean frequency of erroneous sorts of 10.00 for Level IIA, 16,75 for Level IIB and 24.25 for Level III. With the previous mean error frequency of 4.00 for Level I, Level IIB seemed the best representation of a sorting task of intermediate difficulty, and that task was selected for Level II sorting and response mapping.

Further experimentation using the above three level desing (I, IIB and III) confirmed a graduated increase in task difficulty (Level I: $\bar{x}$ = 3.40; Level II: $\bar{x}$ = 13.60; Level III: $\bar{x}$ = 21.67); however a large SD value was noted with Level II (SD = 9.81). In addition, reaction time to unusual tones in the secondary task did not correlate with work load increase in the primary task, ($\bar{x}$ = 478.14 for Level I, $\bar{x}$ = 428.35 for Level II, $\bar{x}$ = 453.95 for Level III).

The experiment that proceeded included only Levels I and III. ONly one type tone was presented to the subject and reaction time was measured in response to that tone alone. Results indicated a large increase in error rate from Level I and Level III (I: $\bar{x}$ = 7.20; III: $\bar{x}$ = 20.20) but again reaction time did not hold up as a subjective indicator of workload (I: $\bar{x}$ = 579.47 m sec.; sd = 24.17, III: $\bar{x}$ = 680.13 msec. ; sd = 42.96).

In summary, it appears that the tasks of pressing a button in response to a tone does not interfere with the primary sorting task. A task based on a simple motor response to precategorical information (tones) does not share enough similarity with the more cognitive sorting task to be influence by the difficulty level of the latter. It is our prediction that if the secondary task was made harder it might better reflect the subjective difficulty of the primary task.

Appended data for Experiment #B09 reflect behavioral responses (primary and secondary task) to the finalized experimental task in which Levels I and II only were run, and in which EEG data were collected during the subjects task performance. Data analysis procedures for interpreting the EEG data and relating them to behavioral data are currently under development. That step will constitute the final phase of the biocybernetics experiment. Visual inspection of the EEG data indicates that waveforms will differ in latency and magnitued when EPs to tones presented during Level I and Level III task are analyzed.

APPENDIX

AMBIGUITY QUESTIONNAIRE

ON

MESSAGE SOURCES

PURPOSE: - To identify 64 unambiguous organization names as message sources for each message file;
- identify 8 unambiguous sources for each possible combination of the three source features, per file;
- eliminate ambiguity of government/private and of health/non health decision tasks;
- randomize occurrence of person/office feature with each file.

BIOCYBERNETICS QUESTIONNAIRE

Instructions: For each organization, please make two decisions: 1) whether it is a government organization or a private one, and 2) whether it is health-related or not health-related. Indicate government or private by circling "G" or "P" immediately to the right of each organization name. Similarly, indicate health-related or not health-related by circling "H" or "NH" next to the right margin of each page. Exmaples are provided below.

Organization				
Voice of America	(G)	P	H	(NH)
American Rifle Association	G	(P)	H	(NH)

Try to complete this task for all 100 organizations, but do not spend a great deal of time trying to make the required decisions. Thank you for your cooperation.

Organization				
Pittsburgh Health Department	(G)	P	(H)	NH
World Future Society	G	(P)	H	(NH)
Center for Disease Control	(G)	P	(H)	NH
Tennessee Valley Authority	(G)	P	H	(NH)
Energy Research and Development Agency	(G)	P	H	(NH)
American Civil Liberties Union	G	(P)	H	(NH)
National Association for Mental Health	G	(P)	(H)	NH
National Easter Seal Society for Crippled Children and Adults	G	(P)	(H)	NH
Surgeon General's Office	(G)	P	(H)	NH
President's Committee on Mental Retardation	(G)	P	(H)	NH
National Association of Broadcasters	G	(P)	H	(NH)
House Armed Services Committee	(G)	P	H	(NH)
National Society for the Prevention of Blindness	G	(P)	(H)	NH
National Center for Health Statistics	(G)	P	(H)	NH
American Hospital Association	G	(P)	(H)	NH
Senate Subcommittee on Health	(G)	P	(H)	NH
HEW Office for the Handicapped	(G)	P	(H)	NH
Corcoran Gallery of Art	G	(P)	H	(NH)
Miami Boatowners Clubs	G	(P)	H	(NH)
United States Information Agency	(G)	P	H	(NH)
University of Pennsylvania	G	(P)	H	(NH)
Izaak Walton League	G	(P)	H	(NH)
American Medical Association	G	(P)	(H)	NH
Small Business Administration	(G)	P	H	(NH)
Department of Health Education and Welfare	(G)	P	(H)	NH
Massachusetts Department of Health	(G)	P	(H)	NH
Miami State Weather Bureau	(G)	P	H	(NH)
Educational Testing Service	G	(P)	H	(NH)
WYRE News Agency	G	(P)	H	(NH)

National Injury Information Clearinghouse	(G)	P	(H)	NH	
Senate Subcommittee on Alcoholism and Narcotics	(G)	P	(H)	NH	
Agriculture Department	(G)	P	H	(NH)	
National Association of the Deaf	G	(P)	(H)	NH	
National Education Association	G	(P)	H	(NH)	
League of Women Voters	G	(P)	H	(NH)	
Pentagon	(G)	P	H	(NH)	
American Speech and Hearing Association	G	(P)	(H)	NH	
Federation of American Hospitals	G	(P)	(H)	NH	
Fourth Circuit Court of Appeals	(G)	P	H	(NH)	
Public Citizen Health Research Group	G	(P)	(H)	NH	
American Physical Therapy Association	G	(P)	(H)	NH	
National Library of Medicine	(G)	P	(H)	NH	TYPO
NEW Office of Maternal and Child Health	(G)	P	(H)	NH	
Senate Veteran's Affairs Committee	(G)	P	H	(NH)	
Environmental Protection Agency	(G)	P	H	(NH)	
Wilderness Society	G	(P)	H	(NH)	
Sage Publishing Company	G	(P)	H	(NH)	
National Council on Alcoholism	G	(P)	(H)	NH	
Justice Department	(G)	P	H	(NH)	
Cryogenics, Inc.	G	(P)	(H)	NH	
HUD Lead-Based Paint Hazard Elimination Program	(G)	P	(H)	NH	
Alcoholics Anonymous	G	(P)	(H)	NH	
American Psychiatric Association	G	(P)	(H)	NH	
Consumer Action for Improved Food and Drugs	G	(P)	(H)	NH	
Defense Intelligence Agency	(G)	P	H	(NH)	
National Eye Institute, NIH	(G)	P	(H)	NH	
Brookings Institution	G	(P)	H	(NH)	

Alcohol, Drug Abuse and Mental Health Administration	G	P	H	NH
House Subcommittee on Health and the Environment	G	P	H	NH
Georgetown University Monitoring Station	G	P	H	NH
Society for Wildlife Preservation	G	P	H	NH
Animal and Plant Health and Inspection Service	G	P	H	NH
National Heart and Lung Institute, NIH	G	P	H	NH
American Marketing Association	G	P	H	NH
Planned Parenthood	G	P	H	NH
St. Mary's Hospital, Philadelphia	G	P	H	NH
Howard University	G	P	H	NH
United Mine Workers	G	P	H	NH
U.S. Naval Academy	G	P	H	NH
Action for Children's Television	G	P	H	NH
Food and Drug Administration	G	P	H	NH
Washington Post	G	P	H	NH
Supreme Court	G	P	H	NH
Georgetown University Health Maintenance Organization	G	P	H	NH
National Institute of Dental Research	G	P	H	NH
Congressional Joint Atomic Energy Commission	G	P	H	NH
Epilepsy Foundation of America	G	P	H	NH
Federal Communications Commission	G	P	H	NH
Blue Cross Association	G	P	H	NH
Veterans Administration	G	P	H	NH
Senate Subcommittee on Health of the Elderly	G	P	H	NH
National Organization of Women	G	P	H	NH
Screen Actors Guild	G	P	H	NH
Defens Nuclear Agency	G	P	H	NH
American Heart Association	G	P	H	NH

National Health Federation	G	P	H	NH
National Institute for Drug Abuse	G	P	H	NH
National Institutes for Health	G	P	H	NH
Kaiser Health Foundation	G	P	H	NH
Group Health Association of America	G	P	H	NH
U.S. Coast Guard	G	P	H	NH
Pittsburgh State Health Office	G	P	H	NH
Commerce Department	G	P	H	NH
Mayo Clinic		P	H	
Department of the Navy	G			NH
Sierra Club		P	H	NH
Labor Department	G		H	NH
National Science Foundation	G	P	H	NH
Army Research Office	G	P	H	NH
United Press International	G	P	H	NH
American Cancer Society	G	P	H	NH
HEW Rehabilitation Services Administration	G	P	H	NH

AFTER ADMINISTRATION OF FIRST QUESTIONNAIRE

LOW-ERROR
LIST

PRIVATE/HEALTH

1. Alcoholics Anonymous
2. American Medical Association
3. Public Citizen Health Research Group
4. American Physical Therapy Association
5. Blue Cross Association
6. Kaiser Health Foundation
7. Mayo Clinic
8. American Psychiatric Association
9. American Speech and Hearing Association
10. Georgetown University Health Maintenance Organization
11. Federation of American Hospitals
12. Group Health Association of America
13. American Cancer Society
14. American Heart Association
15. Epilepsy Foundation of America
16. St. Mary's Hospital, Philadelphia

GOVERNMENT/HEALTH

1. National Institutes for Health
2. National Library of Medicine
3. Department of Health, Education and Welfare
4. Massachusetts Department of Health
5. Center for Disease Control
6. National Institute for Dental Research
7. Senate Subcommittee on Health
8. House Subcommittee on Health and the Environment
9. HEW Office for the Handicapped
10. President's Committee on Mental Retardation
11. Surgeon General's Office
12. Food and Drug Administration
13. Alcohol, Drug Abuse and Mental Health Association
14. HEW Rehabilitation Services Administration
15. Senate Subcommittee on Alcoholism and Narcotics
16. HEW Office of Maternal and Child Health
17. HUD Lead-Based Paint Hazard Elimination Program

Cont

GOVERNMENT/NOT HEALTH

1. Pentagon
2. Justice Department
3. Supreme Court
4. Labor Department
5. Commerce Department
6. Fourth Circuit Court of Appeals
7. Agriculture Department
8. U.S. Naval Academy
9. House Armed Services Committee
10. Defense Intelligence Agency
11. U.S. Coast Guard
12. Department of the Navy
13. Army Research Office
14. Federal Communications Commission
15. United States Information Agency
16. Energy Research and Development Agency

PRIVATE/NOT HEALTH

1. Corcoran Gallery of Art
2. WYRE News Agency
3. Miami Boatowners Clubs
4. Society for Wildlife Preservation
5. American Marketing Association
6. Washington Post
7. Sage Publishing Company
8. Sierra Club
9. Izaak Walton League
10. National Organization of Women
11. National Association of Broadcasters
12. American Civil Liberties Union
13. Harvard University
14. Educational Testing Service
15. United Mine Workers
16. League of Women Voters

DATA

FROM

1ST DESIGN

SAMPLE DATA FROM TWO SUBJECTS

MEAN REACTION TIME (MSEC)

Subject 8	Day 1	Day 2	Day 3	Day 4	Day 5
Level I	752	726	733	739	---
II	777	738	756	738	---
III	767	745	757	756	---
Subject 9					
Level I	699	688	648	662	641
II	724	656	644	---	653
III	---	692	658	650	643

INCORRECT RESPONSES

Subject 8					
Level I	2-1-2	4-0-0	1-1-0	3-2-3	---
II	2-15-3	4-15-2	4-22-5	4-25-59	---
III	6-21-7	5-25-4	3-25-7	4-26-7	---
Subject 9					
Level I	0-0-0	0-0-0	2-0-1	1-1-0	---
II	1-20-1	0-25-0	2-9-0	---	---
III	---	3-9-2	2-8-1	3-7-1	---

PERCENTAGE INCORRECT RESPONSES

LEVEL I

	Mean	Range	
Response 1	1.6	0 - 3.1	Intra/Extra
Response 2	1.7	0 - 2.2	Gov't/Private
Response 3	1.3	0 - 3.4	Individual/Office

LEVEL II

	Mean	Range	
Response 1	1.8	0 - 7.3	Intra/Extra
Response 2	33	11 - 44	Gov't/Private
Response 3	3.9	8 - 33	Individual/Office

LEVEL III

	Mean	Range	
Response 1	4.6	0 - 15	Intra/Extra
Response 2	33	1.4 - 45	Gov't/Private
Response 3	7.7	1.4 - 45	Individual/Office

MEAN REACTION TIME

	Mean	Range
LEVEL I	680	623 - 752
LEVEL II	688	643 - 777
LEVEL III	731	637 - 767

(Week of June 20)

PRIMARY TASK
(Errors)
FIRST SESSION

Subject #	LEVEL I* #Errors	LEVEL I* % in Error	LEVEL II* #Errors	LEVEL II* % in Error	LEVEL III* #Errors	LEVEL III* % in Error
0029	3	4.7%	10	15.7%	28	43.8%
0030	2	3.1%	5	7.8%	26	40.6%
0031	0	0.00%	2	3.1%	38	59.4%
0032	4	6.2%	-	--	--	--
0033	13	20.3%	19	29.7%	40	62.5%
0034	3	4.7%	16	25.0%	27	42.2%
0037	6	9.4%	37	57.9%	34	53.1%
0038	4	6.2%	8	12.5%	29	45.3%
$\bar{x}$ =	4.38		13.86		31.71	
** s.d.=	3.89		11.80		5.62	

SECOND SESSION

0029	-	-	-	-	-	--
0030	-	-	2	3.1%	17	26.6%
0031	-	-	-	-	-	--
0032	-	-	4	6.3%	16	25.0%
0033	6	9.4%	6	9.4%	23	35.9%
0034	-	-	-	-	-	--
0037	4	6.2%	28	43.8%	30	46.8%
0038	2	3.1%	5	7.8%	20	31.3%
$\bar{x}$ =	4.00		9.00		21.20	
s.d.=	2.00		10.72		5.63	

*Level I - Sort on one feature
" II - Sort on two features
" III - Sort on three features

** $\bar{x}$ = Mean
s.d.= Standard Deviation

(Week of June 20)

SECONDARY TASK
(Reaction Time)*

FIRST SESSION

Subject #	LEVEL I Mean RT on hits	LEVEL I #Misses	LEVEL II Mean RT on hits	LEVEL II #Misses	LEVEL III Mean RT on hits	LEVEL III #Misses
0029	313.93	15	334.86	14	283.93	15
0030	355.70	13	431.25	13	541.00	17
0031	413.10	12	382.30	15	461.58	14
0032	258.00	14	--	--	--	--
0033	431.50	13	394.77	11	444.08	12
0034	434.42	13	502.22	17	515.30	15
0037	591.40	15	632.14	17	633.89	16
0038	479.53	13	655.20	12	363.60	15
$\bar{x}$ =	409.70		476.11		463.34	
s.d.=	102.88		805.65		115.71	
median=	422.30		131.25		461.58	

SECOND SESSION

0029	--	--	--	--	--	--
0030	--	--	455.42	12	524.27	11
0031	--	--	--	--	--	--
0032	--	--	424.92	13	330.64	14
0033	299.54	13	349.70	13	264.62	16
0034	--	--	--	--	--	--
0037	465.66	12	458.08	12	479.50	12
0038	303.30	16	570.10	12	391.10	14
$\bar{x}$ =	356.17		451.64		398.03	
s.d.=	94.84		79.36		106.02	
median=	303.30		455.42		391.10	

*Reaction time collected on response to salient tone recorded with button held in left hand.

ATTEMPTS TO FIND A MORE INTERMEDIATE LEVEL OF TASK DIFFICULTY AS REFLECTED IN MESSAGE SORTING ERRORS

- Tests on Levels II_A and II_B

(June 29,30, July 1)

PRIMARY TASK
(Errors)
FIRST SESSION

Subject #	LEVEL I #Errors	LEVEL I % in Error	LEVEL II #Errors	LEVEL II % in Error	LEVEL III #Errors	LEVEL III % in Error
0039	22	34.4%	28	43.8%	32	50.0%
0040	25	39.1%	28	43.8%	27	42.9%
0041	18	28.1%	17	26.6%	18	28.1%
0042	25	40.6%	24	37.5%	33	51.6%
$\bar{x}$ =	22.50		24.25		27.50	
s.d.=	3.32		5.20		6.86	

SECOND SESSION

0039	6	9.4%	8	12.5%	14	21.9%
0040	4	6.3%	24	37.5%	25	39.1%
0041	6	9.4%	8	12.5%	24	37.5%
0042	24	37.5%	27	42.2%	34	53.1%
$\bar{x}$ =	10.00		16.75		24.25	
s.d.=	9.43		10.18		8.18	

(June 29,30, July 1)

SECONDARY TASK (Reaction Time)

FIRST SESSION

Subject #	LEVEL I Mean RT on hits	LEVEL I #Misses	LEVEL I False Alarms	LEVEL II Mean RT on hits	LEVEL II #Misses	LEVEL II False Alarms	LEVEL III Mean RT on hits	LEVEL III #Misses	LEVEL III False Alarms
0039	673.00	7	23	699.67	2	22	705.75	0	21
0040	368.00	43	17	316.50	42	13	175.60	39	15
0041	000.0*	00	25	000.0*	1	25	000.0*	0	25
0042	539.20	0	20	640.80	0	15	574.55	0	14
$\bar{x}$ =	526.73			552.32			485.30		
							276.11		
s.d.=	152.88			206.34					
median=	539.20			640.80			574.55		

SECOND SESSION

0039	638.00	0	12	609.89	0	16	710.00	0	19
0040	498.68	0	13	466.69	0	12	589.82	0	15
0041	575.40	22	20	335.50	8	21	000.00*	1	25
0042	526.50	0	13	500.18	0	14	560.56	0	16
$\bar{x}$ =	559.65			478.07			620.13		
s.d.=	61.11			113.02			79.20		
median=	550.95			483.44			589.82		

*Subject indicated he was purposely ignoring secondary task when questioned by examiner between third and second levels of the second session. Thereafter, subject responded to tones.

(July 11,12,13,14)

PRIMARY TASK
(Errors)
FIRST SESSION

Subject #	LEVEL I #Errors	LEVEL I %in Error	LEVEL II #Errors	LEVEL II % in Error	LEVEL III #Errors	LEVEL III % in Error
0037	1	1.6%	37	57.8%	37	57.8%
0039	1	1.6%	5	7.8%	21	32.8%
0043	0	0.0%	20	31.3%	13	20.3%
0045	12	18.8%	6	9.4%	7	10.9%
$\bar{x}$ =	3.50		17.00		19.50	
s.d.=	5.69		14.99		13.00	

SECOND SESSION

0037						
0039						
0043						
0045						
$\bar{x}$ =						
s.d.=						

(July 11,12,13,14)

SECONDARY TASK
(Reaction Time)
FIRST SESSION

Subject #	LEVEL I Mean RT on hits	LEVEL I #Misses [False Alarms]		LEVEL II Mean RT on hits	LEVEL II #Misses [False Alarms]		LEVEL III Mean RT on hits	LEVEL III #Misses [False Alarms]	
0037	437.85	50*	12	572.92	1	12	550.50	0	13
0039	543.69	0	12	612.09	0	14	707.00	0	19
0043	268.23	0	12	352.46	0	11	299.15	0	12
0045	515.36	4	14	526.46	1	12	504.91	0	13
$\bar{x}$ =	441.28			516.00			515.39		
s.d.=	123.74			114.50			168.14		
median=	476.61			549.69			527.71		

SECOND SESSION

0037									
0039									
0043									
0045									
$\bar{x}$ =									
s.d.=									

*In first level, subject #0037 was not informed by the examiner to respond only to the high tones. Subject was informed before levels II and III.

(July 20,21,22)

PRIMARY TASK
(Errors)
FIRST SESSION

Subject #	LEVEL I #Errors	LEVEL I % in Error	LEVEL II #Errors	LEVEL II % in Error	LEVEL III #Errors	LEVEL III % in Error
0046	10	15.6%	23	35.9%	13	20.3%
0047	2	3.1%	18	28.1%	24	37.5%
0048	6	9.4%	17	26.6%	--	--
0049	6	9.4%	33	51.6%	35	54.7%
0050	10	15.6%	24	37.5%	31	48.4%
0051	3	4.7%	13	20.3%	20	31.2%
$\bar{x}$ =	6.17		21.33		24.60	
s.d.=	3.37		7.00		8.75	

SECOND SESSION

0046	5	7.8%	10	15.6%	--	--
0047	5	7.8%	10	15.6%	--	--
0048	(No Show)					
0049	1	1.6%	31	48.4%	25	39.0%
0050	5	7.8%	10	15.6%	21	32.8%
0051	1	1.6%	7	10.9%	19	29.7%
$\bar{x}$ =	3.40		13.60		21.67	
s.d.=	2.19		9.81		3.06	

(July 20,21,22)

SECONDARY TASK
(Reaction Time)
FIRST SESSION

Subject #	LEVEL I Mean RT on hits	LEVEL I #Misses (False Alarms)		LEVEL II Mean RT on hits	LEVEL II #Misses (False Alarms)		LEVEL III Mean RT on hits	LEVEL III #Misses (False Alarms)	
0046	(See Note)			708.25	0	21	603.40	0	16
0047	489.64	2	13	585.80	0	15	599.20	0	15
0048	611.00	1	14	610.75	0	17	--		
0049	596.73	0	10	596.25	0	13	652.36	0	13
0050	409.87	0	10	538.00	0	14	492.00	0	15
0051	548.82	1	14	619.18	0	14	689.89	0	16
$\bar{x}$ =	531.21			609.71			607.37		
s.d.=	82.80			56.03			74.54		
median=	548.82			603.50			603.40		

SECOND SESSION

0046	562.33	0	17	532.44	0	16	--		--
0047	563.46	0	12	541.73	0	16	--		--
0048	--		--	--		--	--		--
0049	547.67	0	12	562.00	0	16	616.42	0	12
0050	370.00	0	12	472.38	0	12	476.75	0	13
0051	525.08	0	13	590.54	0	12	559.40	0	12
$\bar{x}$ =	513.70			539.82			550.86		
s.d.=	81.81			43.79			70.23		
median=	547.67			541.73			559.40		

Note: Subject not informed correctly on high and low tones; subject responded to low tones only. (Experimenter did not realize there was a pitch difference.)

*Some secondary data bad.

EXPERIMENT #B09

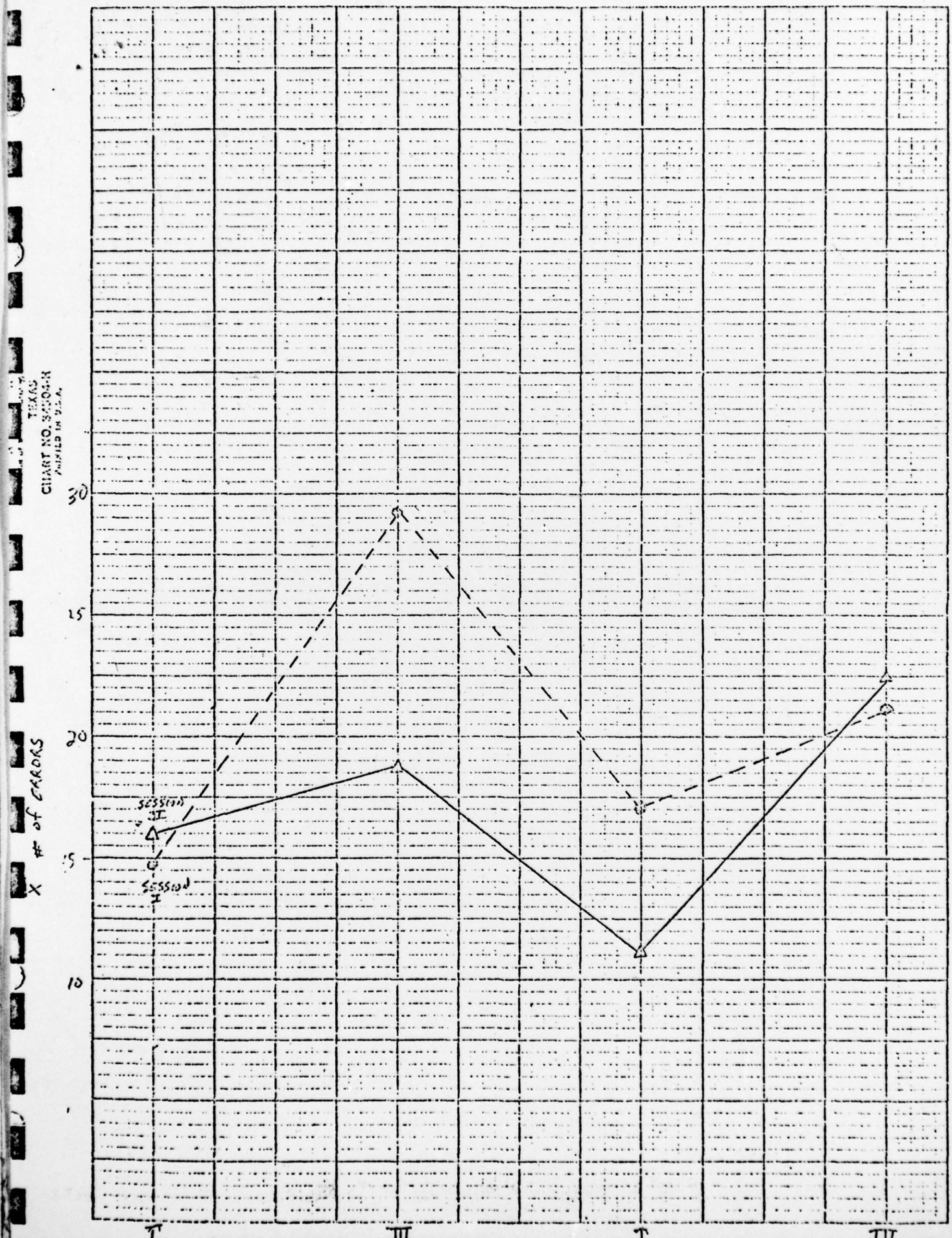
BEHAVIORAL TASK DATA

SESSION I

SUBJECT	LEVEL I	LEVEL III	LEVEL I	LEVEL III
	ERRORS	ERRORS	ERRORS	ERRORS
0101	14 (22%)	22 (35%)	NO DATA	NO DATA
0102	0 (00%)	12 (19%)	6 (9%)	3 (5%)
0103	5 (8%)	18 (28%)	12 (19%)	13 (20%)
0104	6 (9%)	35 (54%)	9 (14%)	14 (22%)
0105	13 (20%)	41 (64%)	10 (16%)	32 (50%)
0106	3 (5%)	21 (33%)	7 (11%)	3 (5%)
0107	55 (85%)	53 (83%)	60 (94%)	54 (84%)
0108	9 (14%)	31 (48%)	11 (17%)	22 (34%)
0109	29 (45%)	31 (48%)	24 (37%)	29 (45%)

SESSION II

SUBJECT	LEVEL I	LEVEL III	LEVEL I	LEVEL III
	ERRORS	ERRORS	ERRORS	ERRORS
0101	11 (17%)	18 (28%)	11 (17%)	17 (27%)
0102	6 (09%)	7 (11%)	6 (9%)	NO DATA
0103	10 (16%)	13 (20%)	6 (9%)	20 (31%)
0104	7 (11%)	12 (19%)	6 (9%)	27 (42%)
0105	14 (22%)	22 (34%)	8 (12%)	32 (50%)
0106	6 (9%)	12 (19%)	4 (6%)	12 (19%)
0107	58 (91%)	43 (67%)	33 (52%)	29 (45%)
0108	8 (12%)	13 (20%)	3 (5%)	11 (17%)
0109	24 (37%)	29 (45%)	26 (41%)	32 (50%)


TEXAS
CHART NO. 5020-R
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30
25
20
15
10
5
# of ERRORS
Session II
Session I
I
II
I
II